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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

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Too Much for Granted

As a nation the British are inclined to take too much for granted without giving thought to what has been or is being done to create the "generally accepted." The catching of the 8.30 train or 'bus or tramway-car occasions no thought other than lateness or capacity in relation to comfort of travel. No thought is given to the standardisation of rails, or tyre dimensions, or voltages. Yet for the smooth working of transport, engineers and technicians have for many years devoted much time and effort in order that standard conditions should be instituted so that manufacturing processes may be simplified to the ultimate benefit of the man in the street. For standards to be acceptable they require the endorsement of manufacturer and user, and the machinery for their creation largely centres in the technical associations, using as the hub either the British Standards Institution or the national buying authorities. It is an everyday affair for a foundry concern to receive an order for castings to be made to a B.S.I. specification, the order being accompanied by a set of patterns. The modern foundry for the fulfilment of this order calculates a mixture of metals and alloys based on chemical analysis, and controls the physical condition of the sand to be used for the moulds. A record is kept of all costs in order to ascertain that the money expended in labour and materials is recovered and a margin secured for the future welfare of the business. All these things are taken for granted just as much as is that 8.30 train, tram or 'bus. We accept these things as being in the very nature of things, and too few of us go beyond to inquire what has made these operations so simple, or conjecture whether the future will see further simplification of business and manufacturing operations.

It is our impression that when a foundry handles an order carrying a B.S.I. specification number, not many now give a thought to those enlightened members of the Institute of British Foundrymen who worked hard to launch and direct this obviously desirable work of rationalisation. The Institute also sponsored the standardisation of pattern colours, which has done so much to obviate mistakes. The technology used in the preparation of the metal mixtures and in the control of moulding sand has been grafted on to the industry by the publication of many hundreds of valuable Papers, and finally the means of ascertaining reliable costs has been made easily available through much voluntary hard work and the sacrifice of leisure. We like these things to be taken for granted, as it is the consummation of the ideals for which so many pioneers have laboured. But there is a danger, as one well knows, in taking too many things for granted, and one of them appears to be that the bodies which have produced technological and business standards and created conditions for the proper control of the foundry industry will continue to do so. No doubt they will, but a sense of fairness demands that all who benefit—and what foundry does not—must give their full support, technical if at all possible, but most certainly financial. It is axiomatic that the strength and usefulness of the Institute of British Foundrymen depends on the fullest measure of support being given to it by every foundry in the country. Other organisations working for the common good of the individual firms comprising the foundry industry are no less entitled to expect the fullest support to be accorded their efforts. These organisations may be purely technical, mundanely commercial, or intricately hybrid in their scope—all work for the good of the industry as a whole. Rain-water goods have just been accorded a higher price. "About time, too," has probably been a general comment. But price increases are not granted out of the pure goodness of heart of the controlling authorities. Cases have to be made out and claims substantiated, and this work can be done only by some central organisation. Equally, some such organisation, call it Institute, Association, or what you will, is needed to take care of matters of technical progress and research. These several functions cannot be fulfilled without the expenditure of much time and much money and a good deal of labour. In the nature of things the labour cannot be equally shared, but every member of the industry can contribute his quota to providing finance where necessary, and, what is no less valuable, the moral support which the organisations that are working so hard for the foundry trades are surely entitled to expect.

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Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Birthday Congratulations

To the Editor of the FOUNDRY TRADE JOURNAL.

DEAR SIR,—I should like to join with the many who will wish to congratulate you on the attainment of your 21st Editorial Birthday.

Perhaps it was personal modesty or it may have been great pressure of your editorial space which prevented you from including a reference to the important position the Journal itself has achieved in the realm of metallurgical literature. The importance of the "F.T.J." is recognised wherever metallurgists are to be found, irrespective of language or nationality. On many occasions when travelling abroad I have been surprised and impressed to find the "F.T.J." looked forward to and so frequently quoted.

I know that this has been a matter of great personal interest to you, and it represents yet another achievement which, in my view, should be recorded at this time. Wishing you and the Journal many happy returns of the day.—Yours, etc.,

J. E. HURST.

Ashleigh, Trent Valley Road, Lichfield, Staffs.
November 29, 1941.

Large Pipes made in India

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I was interested to see this note on page 336 of your issue of November 20. As I was the foreman moulder who made these pipes of 102 in. dia., I should just like to point out that the moulds for these were swept up in the shop floor. A large baseplate was set down and swept up with a print in it to take the coreplate. Then the core was swept up with building plates intermittently spaced to stiffen the building up. When the core was "stiffened up" it was lifted from the bottom part and dried in a pit with a fire in the centre of the core building. The cope of the mould, or centre-part, was swept up in half piece flasks, and joined together after drying; it was finished and blackwashed on the bottom part, or baseplate. The three parts, plus the top, were assembled in a pit for casting, for the sake of safety. A dirt head of about 6 in. was used, and a flush riser. The job was poured with small round drop gates from or rather over the top of the dirt head. With only 16 pipes to be made, it would have been a cheaper job if the moulds had been made on the "caged system." The making of half piece flasks *was* an expensive job. Subsequently all our large pipes, plain and with branches, were made from moulds built on the "caged system." I refer to pipes over 48 in. dia. only, of course.

May I through the medium of your paper suggest that it would be interesting to know what company in the British Empire actually holds the record for the largest socket and spigot, or flanged pipe, or plain cylinder made? I do believe that a famous Scottish firm may be in the running for this record with some very large drying cylinders which they have made?—Yours, etc.,

W. BRUCE.

7, Heathfield Avenue, Chesterfield.
November 22, 1941.

Institute of Vitreous Enamellers

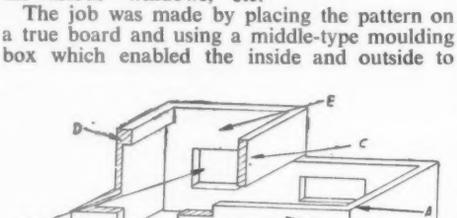
A meeting of the Southern Section of the Institute of Vitreous Enamellers will be held at 49, Wellington Street, London, W.C.1, on Saturday, December 6, at 10 a.m., when further consideration will be given to the current review of the raw materials of the vitreous enamelling industry.

Some Jobbing Foundry Experiences—XXX

By "TRAMP"

Jigs and fixtures are often one-off jobs required in engineering works and are frequently obtained from the nearest jobbing shop. The pattern equipment supplied is not always of the best or made to favour speedy moulding; low pattern costs seem to be one of the features of jig manufacture. Below is an illustration of a box-type jig, a portion of which is removed to show some of the interior detail. The pattern for this jig was practically a replica of the job, excepting that many of the pieces were loose—and could easily be removed from the mould during the process of ramming—to form the various "windows," etc.

The job was made by placing the pattern on a true board and using a middle-type moulding box which enabled the inside and outside to



be rammed simultaneously. On reaching the top of A, a joint was made to take a firebrick, core or slate to cover down the portion of this mould as piece of pattern B had to be extracted at this stage. Ramming was then continued until the top was reached, when a similar procedure was adopted to remove C, D and pieces E forming the top of the windows F. D had to be extracted at this stage as it was too big to be drawn in the mould after the main pattern was withdrawn. A flat "grid" being secured to the middle box, ramming of this portion was completed. The whole was then turned over and the top rammed. On extracting the main pattern the mould was "cleaned off" and made ready for the metal, no cores whatever being used.

Import Duty Exemptions

GOODS NEEDED FOR THE WAR EFFORT

Treasury Orders have been made exempting from duty, under the Safeguarding of Industries Act and the Import Duties Act, a range of goods, including certain iron and steel products, the bulk of which are imported for Government use.

Announcing the decision in the House of Commons, Sir Kingsley Wood, Chancellor of the Exchequer, made it clear that the exemptions are unconnected with tariff policy and are designed as a wartime measure to save the labour of collection of tax from Government Departments. They are made possible by the fact that all imports are subject to rigorous control, and Sir Kingsley Wood said in this connection that all the Departments concerned with imports will maintain their close contacts with industry. He added that if it became necessary to consider the possible war position of our external trade the industries concerned would be called into convocation.

The Order, which took effect as from November 19, under the Safeguarding of Industries Act, includes a number of chemicals and metallic compounds, together with wireless valves and ignition magnetos and certain electrodes and other items. The principal items covered by the main Order under the Import Duties Act are: Ships; springs, tubes and pipes of iron and steel; certain manufactures of copper, aluminium and magnesium and other alloys; rubber tubing and piping; motor-cars and their accessories and parts; tools; insulated wires and cables, accumulators and wireless apparatus of all kinds; together with various munitions.

Random Shots

The latest intensive salvage drive is for waste paper. Everyone is fast becoming paper-conscious. Mother, to the delight of the family, no longer serves up currant cake with a layer of greaseproof glued to the bottom, and Father has stopped writing irate letters to "The Times." He has even stopped writing out cheques, but this is felt to be rather a case of *force-majeur* than of an effort to save paper. The children have sent in a suggestion to the school-teacher that written examinations be dispensed with for the duration; but if this should be considered too drastic, then all questions might be altered from "give in full detail" to "state as concisely as possible." They also think that they could easily give up papering those eternal rooms in the arithmetic lesson in favour of filling tanks. Even the Littlest One has been bitten by the bug, for she has been caught more than once peeling the paper off the nursery wall "to give to the nice paper man." On one point, however, the whole family is in agreement. Father is to be allowed to continue his hobby because postage stamps are really too small to make any appreciable addition to the salvage pile. Besides it keeps him quiet whilst Miss Grown-up-daughter is writing her too copious letter (which will not be long before it becomes salvage paper, she realistically reflects) to her latest soldier friend. Some day, too, that precious paternal philatelic collection might fetch a couple of pounds when the nursery reaches the stage when it simply *must* be re-paper (or distempered?).

* * *

There is, however, no truth in the rumour that the Controller of Salvage has made a personal appeal to President Roosevelt not to declare war on Japan on the plea that it would be a pity to bomb Tokio when so much waste paper is needed in this country.

* * *

"What does B.Sc. mean?" inquired a small girl of her slightly older and more than slightly superior brother.

"It is a high degree for science, specially reserved for bachelors."

"And what is an M.A., then?" went on the seeker after knowledge.

"That's for when they get married, of course. They then become masters of the art," was the ready response.

* * *

A youngster, very anxious about the shortage of milk in the household, was busy reading the priority list. "Oh, mummy," she cried in jubilation. "Can't you be an expectant mother so that the milkman can leave us more milk?"

* * *

This week's crossword clue comes from "The Times":

Clue: See a bird show its teeth in opera.
Answer: Lohengrin.

"MARKSMAN."

Chinese Iron Ore

Exports of iron ore from China in 1940, totalling 230,361 tons, were 126 per cent. above the 1939 shipments. Most of the exports were from North China. In the first two months of 1941, exports of iron ore from Japanese-controlled Chinese territory totalled 44,993 tons, of which Japan proper took 44,920 tons. The Japan Proper Mining Company, exploiting the former Chinese-owned Hsiang Pi Shan iron mine at Tayeh, Hupeh Province, is planning to expand its present monthly production of 10,000 tons of ore. The entire output of this company is shipped to Japan. In 1936 200,000 tons of ore were produced by the Hsiang Pi Shan mines. In order to expedite shipment of iron ore from the Tayeh and Wuhu mines via the Yangtze, it is reported that Japan has decided to build three special freighters for transportation of the ore.

Recent American Developments in Cast Iron*

FURNACE OPERATION—CUPOLA CONTROL—GREY CAST IRON—MATRIX STRUCTURE—S-CURVES AND HEAT TREATMENT—ALLOY ADDITIONS—FLAME HARDENING—PROPERTIES AND STANDARDISATION—MALLEABLE CAST IRON

By A. B. EVEREST, Ph.D.

Introduction

It is not easy under present conditions to select a subject for a Paper. So much that is really interesting comes under the ban of the censor, or must not be discussed for reasons of national security. Foundrymen must therefore be patient, and look forward to a crop of really interesting disclosures after the war, when the inevitable developments under wartime conditions can be freely aired.

In the present instance, the above title for his Paper was selected by the author for a number of reasons. In the first place, under wartime conditions the question of availability of literature from abroad often arises. In view of the splendid work of the Navy and Merchant Service in keeping open the Atlantic, this difficulty has not arisen seriously in the present conflict with regard to U.S.A. publications, and it is truly remarkable to what an extent copies of the journals and other publications have been received regularly from the "other side." At the same time, however, there is another aspect of the problem, in that availability is limited, since extra copies cannot be easily acquired, due to international financial restrictions. In this connection it should be mentioned that this whole difficulty is being met very adequately by the excellent services of our British papers, especially the "Foundry Trade Journal," in giving a prompt review of the work received from abroad.

In the second place, it is felt that a review of recent American literature is justified, since many of those most directly interested are fully occupied with production and have not the time or facilities for studying a large volume of work for themselves.

The main reason for the author's selection of title, however, is something much bigger than the two factors mentioned above and it lies in a realisation that since the war began both the quantity and quality of published work which has reached us from the United States have been outstanding. It seems almost as though since mid-1939 the output of work on cast iron in America has been on a steady crescendo, reaching a climax in the A.F.A. meeting in New York in May, where it is believed more fundamental Papers on cast iron were presented than ever before at any one gathering.

It is the author's job to draw attention to some of the more interesting and important pieces of work published since mid-1939 and to do this a bibliography, covering several of the more important Papers, is appended.

It will be noted that many of the well-known American institutes and universities have participated in the output of work, apart from several of the research organisations associated with industry, as, for example, laboratories connected with the malleable trade and chilled wagon wheels, and also those with a more metallurgical interest connected with molybdenum or nickel. The work from these various organisations carries such well-known names as Boyles, Lorig, Timmons, Crosby, Herzig, Massari, Lindsay, Schwartz, Reese, Flynn and Eash.

The work published by these various people covers several aspects of cast iron development, including melting practice and superheating, alloying and inoculation, heat-treatment and malleablising and special studies of mechanical properties and standardisation.

Foundry Production

It will be realised that the developments of cast iron considered in this Paper apply to the constitution and properties of cast iron as such, rather than to any detailed consideration of the production or properties of particular castings. With this in mind, the question of foundry production is dealt with mainly under the heading of cupola control. A great deal of work has been carried out in the United States in connection with melting furnace operation, the object of a great deal of this being uniformity, and in this connection agreement is felt with the opinion expressed by Kayser at a recent London Branch meeting, when he emphasised that quality was in many respects synonymous with uniformity. It is felt that in the United States, factors tending towards uniformity are more in favour of the foundryman than in this country, owing to the substantially larger quantities of material handled under given conditions. Thus, it is felt to be a matter of general principle that a large cupola is more easily controlled to give a uniform product than is a small one and similarly more stable results will be achieved on a long run than on a short blow. Perhaps the greater tonnage output is partly responsible for the closer attention given to cupola control, but it is nevertheless remarkable that so much attention is given to factors such as blast weight or volume control, moisture control in the blast, temperature of blast, and control over charging operations, etc. A great deal of work has been carried out on cupola control by various organisations where special facilities are available. Some of this work is only now in course of publication, but the conclusion from one such piece of work known to the author is of special interest. This shows that with higher moisture content in the cupola blast, a higher carbon pick-up results, other things being equal. The work in which this conclusion is based will shortly be published and should prove of outstanding interest to the foundryman.

Other studies of cupola operation, especially in the production of high-duty cast iron, are given in Papers by Gillett[2] and by Roth,[3] in which latter the author describes the day-to-day production, and under ordinary foundry conditions, of an alloy cast iron, showing a tensile strength of over 27 tons per sq. in.

It certainly appears from these and similar publications as though in the United States the cupola is used for the production of high-duty cast iron generally to a greater degree than in this country. It is well known that in the U.S.A. extensive use is made of electric furnace melting, but it was the author's experience when last visiting the States, in 1937, that their cupola practice was far in advance of European and little use was made of the rotary furnace or air furnace, apart from the electric furnace.

Reference is made in recent American literature to electric-furnace high-duty irons, a notable case being in a Paper by Barlow.[14]

Grey Cast Iron

With regard to the study of grey cast iron generally, a number of Papers have been published. Throughout these there is a uniform trend to accept the fundamental principle that the properties of cast iron are determined:—(1) By the form of graphite, and (2) by the nature of the matrix of the metal. Some extremely valuable work has been carried out on the formation of graphite in cast iron (see the bibliography[8 9 10 11] appended). Attention is given in each case to the necessity for avoiding the formation of the so-called grain boundary or eutectic type of graphite, which, it is established by the various authors, forms due to the undercooling of the melt at the moment of solidification. Close attention is given to this by Boyles and Lorig,[11] whilst the other authors referred to above all give consideration to the method of solidification of cast iron and emphasise especially the need for inoculation of the melt in order to control the formation of graphite according to the austenite-graphite system, rather than according to the metastable austenite-carbide system. The theories put forward by the different authors explain a great deal, not only with regard to the formation of the undesirable grain boundary graphite structure, but also with regard to the effects of superheating and the general theory of inoculation. This whole aspect of the problem is admirably reviewed in the first part of the Paper by Flynn and Reese.[9]

Some of the latest American work emphasises that graphite form is of far greater importance than the quantity of graphite, and an interesting feature revealed by current American literature is the increased tendency towards high total carbon content in high-duty irons for applications such as brake drums, cylinder liners, etc., where the presence of a relatively large amount of graphite is useful either from the lubrication point of view or for resisting thermal shock.

Another interesting factor of the Papers mentioned above is that, in studying inoculation, the conclusion is reached that silicon is perhaps the most useful material for inoculating an iron which would tend to show undercooling, leading to weak graphite patterns. From the inoculation point of view, however, it is considered desirable in much of the American work to combine deoxidising elements with silicon.[12] A number of special inoculants is now on the market in the United States, some of them having fanciful names (one of which is a special "Vitamin B" dose for cast iron). Inoculation is, however, studied in some of the above Papers from the point of view of graphite liberation in the melt and ties up with the practice, which has previously been noted from the United States, of adding Mexican graphite immediately prior to casting.

Matrix Structure

A study of the various Papers recently published in the United States, dealing with the control of the matrix in cast iron, leads to the conclusion that alloying and heat-treatment are becoming more and more inseparably combined. A new feature in some of the American Papers on cast iron is the reference to "S-curves." Very briefly, an S-curve relates the length of time taken for the austenite transformation at the various temperatures below the critical. A typical S-curve is shown in Fig. 1. The exact significance of this curve will be appreciated if it be assumed that a piece of cast iron is soaked at a temperature above 750 deg. C. until the matrix of the metal is completely austenitic. The part in question is now cooled rapidly to a given temperature, say 600 deg. C., and held there. After a short lapse of time, measured by point A in Fig. 1, transformation of the austenite commences and continues with time until at point B transformation is complete. If the same piece of iron had been cooled rapidly from the austenite range, to a temperature of,

D

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. R. B. Templeton presiding.

American Cast Iron Developments

say, 350 deg. C., and the time taken for the transformation to commence and complete was again measured, then points C and D would be obtained. If this procedure were followed for all temperatures in the range from 750 deg. C. to room temperature, then curves as shown in Fig. 1 for the commencement and completion of the transformation will be obtained. It will be noted that the time scale in the curves is a log scale. Fig. 1 shows S-curves as for ordinary cast iron. It is now established, however, that the shape of the S-curve varies substantially with composition, and especially with alloy content. Furthermore, the shape of the S-curve is closely related to the structures which will be developed in the metal under given heat-treatment, since, as shown in Fig. 1, various structures are evolved by transformation of the austenite at different temperatures; thus, at point A, a pearlitic structure is obtained, whilst at point E a martensitic structure results on the rapid cooling of the specimen to a temperature of about 200 deg. C. At intermediate points, such as C, intermediate transformation products, such as "sorbite" or "troostite," will be obtained. With alloying, the shape of the S-curve is changed substantially and, generally speaking, the whole curve is pushed over to the right. An indication of the effect of alloying on the shape of the curves for the commencement of transformation is given in Fig. 2.

The whole S-curve technique was evolved in the first place by Bain, in connection with alloy steels. It is, however, now being extensively applied to cast iron in explanation of the modification of structure by alloys and heat-treatment. Thus, for an addition of nickel, the first high-speed transformation, represented at A in Fig. 1, is pushed over to the right so that, whilst ordinary cast iron would transform to pearlite, with nickel cast iron a normal cooling rate may be too fast for the pearlitic transformation to get started. In this case, the austenite transforms at the lower temperature ranges, and an iron with a martensitic matrix results. The influence of alloy additions on the S-curves is dealt with at some length by Flynn and Reese.[9]

Heat-Treatment

The S-curves are of greater interest, however, in connection with developments in the heat-treatment of the cast iron. Bartholomew[16] in 1940 published details of a special patented heat-treatment for improving the properties of iron castings. The method of heat-treatment described by Bartholomew is now well known in the United States under such names as the "hot-quenching" of cast iron, the "isothermal treatment" of iron, or as "austempering." This heat-treatment, which can be applied to all ferrous materials, is based on the S-curve. Previously, if an iron of improved quality and wearing properties was desired, it was usual to apply a quench in a cold medium, followed by tempering. By the isothermal treatment now recommended, equally good or superior mechanical results can be achieved by quenching the article directly into a salt or metal bath, held at a moderate temperature, *e.g.*, in the range of 200 to 300 deg. C., and which gives a direct breakdown of the austenite to martensite or an intermediate product. The great advantage of this treatment is that it overcomes the difficulties and dangers associated with the quenching of complicated parts under conditions liable to cause fracture or cracking, and undoubtedly isothermal treatment is a substantial advance in cast-iron metallurgy, and will be of great value and service in the future.

Bartholomew[16] in his Paper gives details of the isothermal quench, and shows that substantial advantages are obtained by quenching plain and alloy cast irons from about 850 deg. C. in a bath at 266 deg. C., and after holding at that temperature for 15 mins. the parts in question are slowly cooled.

Another important Paper dealing with isothermal treatment is that by Nagler and Dowdell.[17] A further interesting point is the development, especially by means of molybdenum additions to cast iron, of the so-called acicular structure. Flynn and Reese[9] deal extensively with the development of this structure by alloying, and also refer to its formation in relation to S-curves.

Alloy Additions

Although a considerable amount of work has been carried out in the United States on alloy

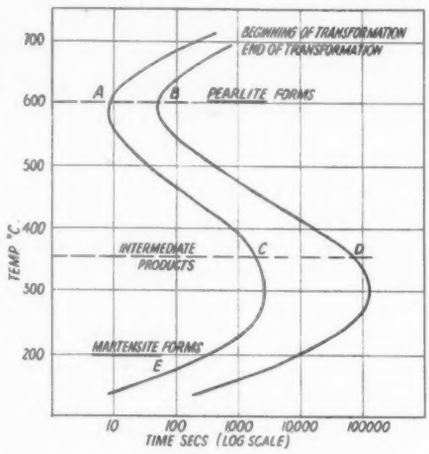


FIG. 1.—S-CURVES FOR AN ORDINARY CAST IRON.

additions, there is perhaps in this direction less fundamental change in the position than in other aspects of iron foundry metallurgy. The outstanding results achieved with combinations such as nickel and molybdenum were recognised before the war and, as is only to be expected, the work[19] of Timmons, Crosby, Herzig and Young of the molybdenum laboratories has continued. Extensive reference is also made in American literature to the production of high-duty cast iron with other alloy additions, including copper, etc., and it now appears from

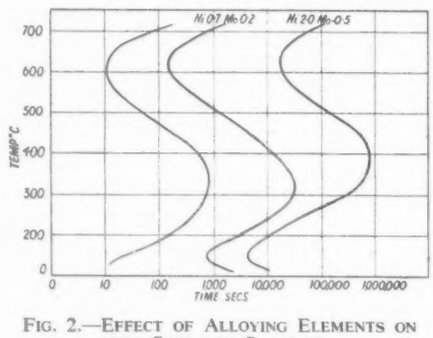


FIG. 2.—EFFECT OF ALLOYING ELEMENTS ON THE SHAPE OF S-CURVES.

these references that it is general practice for cast iron to be produced to specification grades higher than anything visualised in this country up to the present. In addition to the usual strengthening elements, work has also been carried out with other additions, including elements such as vanadium, tellurium and boron.

Flame Hardening

The Americans have given detailed attention to the flame hardening of high-duty castings, especially for machine tool production, and in this connection have published a certain amount of information based on their experience. Those interested in this aspect of the treatment of iron castings would be well advised to refer to the Paper by Sefing[23] and a long series of articles by Hartley,[24] who studies the question of standardising all the factors involved in flame hardening. As in the case of many other problems, satisfactory results have been achieved by flame hardening on a production scale, when the volume of work to be turned out is sufficiently great to justify a complete standardisation of all the various factors and variables involved. Other Papers, of perhaps less importance, deal with more specialised applications of flame hardening, as, for example, to lathe beds.

The properties resulting from flame hardening appear to be of an extremely high order, and the general conclusion seems to be that alloy high-duty cast iron should be used, since with alloys a greater response and uniformity of result is achieved with minimised distortion, or alternatively a given result may be obtained with a milder heat-treatment.

Properties and Standardisation

As would be expected in parallel with the various Papers mentioned above, there have been a number of investigations described in the Press, dealing with the special properties of cast iron. Some of these are of a very advanced nature, as, for example, in the case of the Paper by Collins and Smith[26] on the high temperature fatigue properties of cast iron.

A very useful collection of data on cast iron related to the various strength grades covered by the U.S. Specification A.48-36, is contained in a publication on the engineering properties of grey cast iron.[21] Whilst this publication does not draw any extensive general conclusions, it gives a mass of data on particular irons relating the ordinary and some special mechanical properties with chemical analysis and method of production. This publication is of special value to anyone studying the more unusual properties of cast iron.

With reference to standardisation, the Report of the A.S.T.M. Committee A.3[22] is particularly interesting. It reviews the present standardisation position for grey cast iron, and mentions particularly that attempts are being made to standardise impact testing in the United States. The basis of this standardisation is a drop test and the Charpy test. The outstanding feature of this Committee's report, however, is the publication of a proposed standard for graphite form and size, together with tentative recommended practice for polishing and measuring graphite flake size. It is felt that this standard would be of particular value, and should receive a considerable amount of attention, even in this country.

Malleable Cast Iron

The most interesting development in recent American literature on malleable is related to the production of pearlitic malleable prepared by the short cycle annealing process. A Paper fundamental to this process is that by Ziegler, etc.[7] These authors have studied the decomposition rate of cementite, both above and below the critical temperature. They point out that decomposition of primary cementite is rapid at temperatures well above the critical, but is incomplete. Graphitisation of all the primary and excess carbon held in the austenite matrix can only be completed at temperatures just above the critical. Second stage graphitisation progresses most rapidly and completely simultaneously with the formation of pearlite, and they conclude that the most efficient method of graphitising cast iron is therefore to carry it out in steps, combining speed of decomposition with maximum possible graphite formation at each temperature range. Other Papers of fundamental interest in connection with malleable production are given in other references.[27-30]

American Cast Iron Developments

whilst a point of special interest is brought out in the Paper by Cowan,[31] in that he applies austempering to pearlitic malleable cast iron with interesting results. Smith[28] shows that flame hardening can also be applied to malleable castings of correct structure.

Conclusions

This review of American literature since the outbreak of war is necessarily very sketchy and must be regarded as incomplete. The bibliography of reference includes only those Papers which have come to the author's notice and which seem to him to be of outstanding interest to British foundrymen at the present time and, as already mentioned, the selection does not include any Papers referring to the production of castings. Enough has been said above, however, it is felt, to show that American metallurgists are at the present time very actively engaged in studying fundamental problems on cast iron and have succeeded in producing many new facts and theories, all of which help towards the production of ever better products.

Finally, the author would like to record his indebtedness to his colleague, Miss E. W. Parker, who from her technical records was able rapidly and efficiently to turn up some fifty or sixty references to foundry developments in the United States in the period under review.

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Life of Blast Furnace Linings

Discussing the question as to what are the principal factors which affect the life of a blast-furnace lining and what improvements have been made which have prolonged furnace lining life, WM. A. HAVEN, at the annual meeting of the American Iron and Steel Institute, said that the linings of blast furnaces in operation are continuously under attack by the combined forces of abrasion, heat, pressure, slagging and chemical disintegration. Factors which most seriously affect the life of the linings are certain conditions or circumstances which substantially accelerate or retard the intensity of these forces or tend to counteract them. Their relative importance changes from time to time with the overcoming of old problems and the advent of new ones, and is, therefore, often a matter of conjecture and debate.

Faulty Charge Distribution

Over the past 50 years the most serious cause of lining failures was probably faulty distribution of ore, coke and limestone on the top of the stacks during the period when the furnaces were being equipped with mechanical charging. The method of filling by hand provided reasonably uniform distribution, but charging with the earlier types of skips and buckets resulted in segregation of lumps and fines in patterns which caused the gases to channel and the linings to be gouged out prematurely at points where an excess of lumpy materials was placed against the walls.

This trouble was gradually solved by perfecting the design of top-charging equipment, particularly the invention and development of the revolving top. Segregation effects are now distributed in a way to protect the lining rather than damage it, at least when the ores are predominantly fine, as are those of the Lake Superior district. With coarse, hard ores, such as the Nova Scotia and Birmingham hematites, there has been a special problem in distribution, but this has been greatly simplified in recent years by a rapid trend toward the practice of ore crushing.

Crushing and subsequent cleaning and grading of coke, and the steady advancement in all phases of coke manufacture, have also improved the distribution of stock in the furnaces, and, in other ways as well, helped to prolong the life of furnace linings. Soft dirty coke was in part responsible for hearth and bosh breakouts, one of the most hazardous and spectacular as well as expensive forms of lining failure. Breakouts nowadays are of almost rare occurrence due to a long list of improvements which include better coke, better refractories, better hearth and bosh design and construction, better application of hearth and bosh cooling and better casting equipment, notably the high pressure clay gun that is now used for stopping and maintenance of the tap holes.

Many Improvements

Among improvements, both preventative and protective, which have played prominent roles in prolonging the life of those portions of the linings which are above the mantle, are top charging equipment and beneficiation of raw materials, armoured stock-line or wearing plates, improved types and arrangements of stack cooling plates, and the development of refractories which are capable of resisting the effects of carbon deposition, zinc and other agencies of disintegration.

Chemical disintegration of the brickwork has been one of the most frequent causes of lining failure, and the toughest of all lining problems to solve. The brick manufacturers seem finally to be achieving the answer in the successful production of bricks which are denser, more accurately sized, free from laminations and from catalytic oxides, and burned at higher temperatures.

A lining of the best refractories, however, will be seriously affected by the skill of the brick masons, by weather conditions when the lining is installed, by provisions made for expansion, and by carefulness of the management in the drying out, blowing-in and blowing-out periods. Keeping a lining dry and free from frost while standing idle is of particular importance.

Other operating practices which affect lining life are the use of excessively basic or acid slags and the practice of hard driving or overblowing, neither of which, fortunately, is often necessary, since development of big hearths, straighter boshes, and greatly increased overall capacity of the stacks. The modern 1,000-ton furnace is in itself an answer to many of the lining problems of earlier times.

The life of a furnace lining is sometimes expressed by time in blast, but more generally by tons of metal produced. By the latter method, the life of linings has obviously been more affected by the increased daily output of stacks than by any other single factor. However, even keeping this fact in mind, the combined results of the improvement mentioned are impressive. In 1880 a run of 105,000 tons was claimed to be a world's record. At the turn of the century a half-million tons was considered satisfactory. In 1920 the average life was probably about 750,000 tons, and the record about one and a half million tons. In 1940 and 1941 furnace after furnace is reported to have made more than one and a half million tons, and several more than two million tons and still going strong.

Flaw Detection with Gamma Rays

Gamma-ray photographs are now being used to detect flaws in the steel structure of parts of steam turbines, propulsion gears and auxiliary apparatus for United States Navy fighting ships now in production at the Westinghouse Steam Division Works, Lester, Pa. The inspection process uses radium sulphate, of which 500 milligrams are powerful enough for examining 10-in. steel. In detecting flaws, sensitised film is first strapped in place on the outside of the metal—a pipe, for example. Then the radium compound, sealed in a minute silver kernel, which in turn is contained in a pear-shaped aluminium shell, is suspended on a midget rigging placed within the pipe. The film then registers the gamma rays as they penetrate the metal. Flaws in the metal appear on the film as dark areas, for the rays are able to reach the film with greater intensity during an exposure period through flaws than through a solid metallic structure. Exposure of the film varies from a few minutes to 48 hours.

Estimating Hydrogen in Iron and Steel

The available methods for determining minute amounts of hydrogen in steel are discussed in a Paper by V. C. F. HOLM and J. G. THOMPSON in the "Journal of Research" of the U.S. Bureau of Standards. The authors found that a method which involves a vacuum extraction of the hydrogen at 800 deg. C. is rapid, and yields reliable results for a variety of materials. Prompt sampling and immediate analysis are advisable because many samples lose hydrogen during storage, even at room temperature. Alloy steels with high chromium contents dissolve more hydrogen and retain it more tenaciously than do simple steels. Hot-rolled rods of low-carbon steel, some time after they were rolled, had low and uniform contents with no evidence of segregation of the hydrogen.

(*Concluded from first column.*)

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Coal and the Steel Industry

Coal as such, or in the form of coke, has been a dominant factor in the steel industry from the middle of the nineteenth century until recently when other fuels such as natural gas and fuel oil began to enter the picture. To a large extent iron ore has in the past been brought to the coalfields for reduction. But gradually the predominance of coal has been lost, for it is no longer the only source of energy, whether chemical or thermal, as may be seen from Fig. 1. Increasingly less coal and coke have been needed for the production of a ton of pig-iron or steel. During the past two decades the efficiency of the use of coke in the manufacture of pig-iron has shown a constant improvement. The average amount of coke required per ton of pig-iron has declined from 2,375 lbs. in 1918 to 2,017 lbs. in 1938. Improvement in this respect is still being sought, and though the gains from the ironmaker's point of view are becoming more difficult of achievement, the end is certainly not yet in sight.

Although the direct effect of greater efficiencies on the coal industry must not be discounted, no one would contend that the technologic advances that bring about increased efficiency are undesirable. This makes for conservation, while a reduction in cost of the final product unquestionably brings about greater market opportunities and expands the industry, suggests Prof. A. W. Gauger in a recent Paper read before the American Institute of Mining Engineers, reviewing the problems this curtailment of coal consumption by the iron and steel industry brings to the collieries.

Scrap and Shift in Fuels

The second factor in the decreased relative tonnage of coal used by the steel industry ensues from shifts in fuels resulting from changes in technology within the industry itself. More and more scrap metal is being employed in the production of steel, which entails a shift in fuels, for most scrap is fed to the open hearth where it is melted with gas or fuel oil. The consumption of iron ore decreases and this decrease brings a corresponding decrease in coke consumption, as coke is necessary for the reduction of iron ore. In 1939 the total scrap consumed in the United States amounted to 32,234,407 long tons. This would be equivalent to about 65,000,000 tons of iron ore. Approximately 33,000,000 tons of coke would be required to reduce this ore, or about 55,000,000 tons of coal. The amount of scrap used in 1940 probably reached 45 million tons.

It is important that the coal industry analyse this situation and determine why these shifts from coal to fluid fuel have come about, suggests the author. For much too long a time the industry has considered its sole, or at least its chief, problem in connection with the steel industry to be one of producing a coal that will make a coke that will satisfy the blast-furnace superintendent. This is only part of the problem. The coal producer must also study the demands placed upon the fuel by the changing techniques of the industry. The most important factor is the fact that many of the operations in steelmaking have become precision operations requiring extremely close control, much more readily accomplished with fuel oil and natural gas than with coal. This, of course, is not the only factor since availability and cost of these latter fuels are also important; it is, however, a factor of major importance and must be considered by the fuel technologists of the coal industry. If anything is done to change this situation it must be done by the coal industry itself. The steel industry is, of course, operated for profit. So long as natural gas and fuel oil offer cost advantages, the American steel industry will continue to use them.

Recent Trends

While there have been no outstanding changes in the situation in the United States during the past 18 months, the author refers to four developments which should be noticed. One relates to the installation of combination-fired boilers operating on pulverised coal and blast-furnace gas. The second relates to the use of pulverised coal as fuel for open-hearth furnaces melting steel for castings. In both these instances the solid fuel is used in what might be termed a fluid form. The third suggestion relates to the use of coke breeze for smelting iron ore by the Tennessee Coal, Iron & Railroad Company. The fourth is the direct reduction of a New Jersey magnetic iron ore concentrate using activated carbon. A small steel ingot analysing, in part, Fe 98.61, C 0.89, P 0.032, Mn 0.12, S 0.08, has been produced by this process (called the Morfit-Sweetser process) in the metallurgical laboratory of Columbia University. The reaction is believed to have been a solid-phase reaction between activated carbon and the oxide of iron.

It is evident that for certain purposes natural gas and fuel oil have advantages resulting from

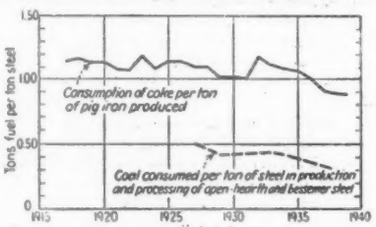

FIG. 1.

their physical form. It may be necessary for coal to assume a more fluid form to compete with the fluid fuels under these circumstances. To liquefy coal by hydrogenation is now out of the question because of the cost involved. But pulverised coal can be used and other possibilities also present themselves. These include gasification of the coal, and preparation of colloidal fuel. Steel mills with blast furnaces and coke plants have a partial supply of clean gas for their requirements. Blast-furnace gas is in itself a useful fuel, though low in heating value. It can be enriched by mixing with coke-oven gas. It is not without the realm of possibility to use blast-furnace gas as a carrier for pulverised coal and thus make a fluid fuel of much greater heating value. The gas producer has not been exhaustively studied as a source of gas from solid fuel although some experiments have been made on the manufacture of water gas from oxygen and steam. So far, the cost of oxygen seems to prohibit this commercially. However, the combination of a synthetic ammonia plant with the recovery of oxygen from the air may offer a future solution to this problem.

(*Continued from next column.*)

There is only one precaution to be taken when allowing the bed to burn several hours, and this is not to allow the coke bed to burn completely away or unnecessarily. After the coke once starts burning, nearly all the draft may be cut off, depending upon the natural draft of the individual cupola.

About one-half of the bed coke is charged when the fire is started, and after this has burned through slowly, approximately another one-quarter of the bed is added, but the bed should be left so low that ten or twelve inches of coke will be required to bring the bed up to the desired level, just prior to charging the first iron.

"Early" Cupola-Firing for Hot Iron*

BY M. L. CARL

Many foundries have worked out a satisfactory practice for assuring uniformly hot iron at the beginning of every heat, but many others are still having trouble in getting their first iron sufficiently hot. Although it is not offered as a "cure-all," the writer recommends in such cases the practice of starting the cupola-fire early—four to six hours before the time for the blast to be turned on.

Many of the larger melters are unconsciously securing the benefits gained by this procedure, because of the necessary time required to burn their coke bed properly, plus the time required to charge the fill-up charges in the larger cupolas—all of which adds up to several hours. On the other hand, many foundries operating small cupolas, or operating cupolas for only one- or two-hour heats, have overlooked the advantages to be had by such a practice.

These advantages are numerous, particularly at present, when the cry is for greater production speed. In most cases, with no change other than the one mentioned, the melting rate of the cupola can be increased an appreciable amount, generally accompanied by a much-desired increase in temperature of the first iron tapped. The increase in melting speed may be enough, in some foundries, to allow the melting of larger tonnages in the same length of time formerly required for smaller heats, and thus permit more time for moulding where moulders pour their own work.

Faster melting during the earlier part of the heat may be expected, since the bed coke has had time to be evenly ignited throughout, thus making the entire cupola area available for melting at the beginning of the heat. With sufficient time thus allowed for the coke near the lining to become well ignited, the lining has enough time to be heated to a red heat in the melting area, which means that the melting zone will reach its maximum temperature much quicker upon starting the heat than would be possible with a colder lining.

Moreover, a hot lining naturally chills the first iron and slag less than a cold lining, largely eliminating the tendency for the slag to stick to the lining and begin bridging, and being less inclined to continue when started. This explains partly why hotter and faster melting may be expected.

Other factors contributing to a hotter iron may be that the patching and daubing materials in the melting zone have been heated slowly and long enough so that they are thoroughly dried, and possibly their surface fused. It stands to reason that patching material that is dried slowly but thoroughly, and then raised to a red heat before being subjected to the intense heat developed shortly after the blower is started, will result in far less bridging and less burning away of the lining, both of which will mean a cleaner cupola, conducive to hot and fast melting.

A foundry interested in allowing the bed coke to burn for a longer time may have to make some radical changes in the habits of the cupola tender and labourers, for ordinarily, they arrange their work so that the cupola is repaired and ready to light the fire, just in time to allow the bed barely to burn through before charging is started. Many times the blower must be started before the cupola is fully charged. This feature must be worked out in the individual foundry, but while the bed is being allowed to burn, the cupola crew will have time to perform their other duties, which they may have been in the habit of doing earlier in the day.

(*Continued in next column.*)

* From the Shop Notes section of "Metals and Alloys."

Iron and Steel Institute

AUTUMN MEETING IN LONDON

The Autumn Meeting of the Iron and Steel Institute was held at the Offices of the Institute, 4, Grosvenor Gardens, London, S.W.1, on Tuesday, November 25, 1941, Mr. John Craig, C.B.E., D.L. (President) in the chair.

Nomination of President

The PRESIDENT said it gave him the greatest pleasure to announce that Mr. James Henderson had been nominated unanimously by the Council for election as President at the annual meeting to be held in 1942. He congratulated Mr. Henderson on being nominated for a position which he was well qualified to occupy.

The PRESIDENT also announced that Dr. Andrew McCance had been nominated by the Council to be a Vice-President of the Institute. He also announced that the Council had unanimously agreed to invite Mr. Walter S. Tower, President of the American Iron and Steel Institute, to be an honorary member of the Iron and Steel Institute.

Collaboration of Polish Metallurgists

DR. W. WRAZEJ (formerly of Starachowice, Poland) said that for him this was an exceptional occasion; for the first time, he was able to attend a meeting of the Iron and Steel Institute, although he had been a member since 1933. He wished to speak on behalf of his Polish colleagues who were also members of the great Iron and Steel Institute as well as on his own behalf, and to offer to the Institute his best wishes for success in all its undertakings, and for the success of the present meeting. Polish technicians, whether in uniform or not, wished to stand firm in the ranks with their British colleagues, and to strain every effort necessary for victory

Having under consideration the concentration of effort for the common goal, the Institute of Technical Research, General Staff of the Polish Army, had been created. It comprised the best Polish technicians, who represented all branches of science, including metallurgy. Looking at the work of this Institute of Technical Research, he saw the effort made by his colleagues who had the opportunity of collaborating with British industry, and he saw how they did their best to carry out the demands and necessities of the moment. In addition to those who were collaborating with British industry, however, many able Polish specialists waited for the opportunity to co-operate in working for the common goal.

It was his opinion that at such an important moment as the present, the hands and brains of these qualified men, good friends of the British nation, should be suitably utilised. He was not asking for any kind of remuneration for them; he asked solely that they should be allowed in common to create the union which would support the mutual life of their two nations in the future. Neither a visit nor mutual social life could found such a friendship, and such a knowledge of each other as could be won in a common workshop or trench in wartime, when the two nations were allied for better or for worse. He hoped that his few but sincere words, addressed to his British colleagues, would be well understood, and that they would stretch out their hands to join with their Polish colleagues more closely than ever in the common effort.

The PRESIDENT assured Dr. Wrazej that his British fellow-members entirely shared his sentiments. Continuing, he said that if he might be allowed a personal word, it would be that his own company had had experience of the help which could be afforded and the ability which could be displayed by some Polish members who had joined their staff in recent months and who were rendering excellent service, service which was highly appreciated not only by the directors of the company, but by many of their workmen, who had been impressed by the efficiency and the enthusiasm of these Polish technicians.

Introductory Remarks by the President

The PRESIDENT went on to say that at such a short meeting he did not propose to make a lengthy speech. The secretary had suggested that he should refer to the work of the Institute, and in that connection he said that, although the Institute had not been able to function as fully as would have been the case in normal circumstances, or take such an active part in organising lectures and debates, it must not be thought that it had been neglecting its work. Under the inspiring leadership of Dr. Hatfield, the Research Committees of the Institute were to-day fully engaged on work of the highest national importance, and were rendering great service to the country by the work which they were doing and by the help which they were giving to all branches of our great Fighting Forces. For that alone the Institute deserved well of the industry and of the country, because of the ability and the help which it was able to place at the disposal of the country as a whole.

He had said before that in his view this was the great opportunity of the scientists to demonstrate their real worth. In ordinary times they were sometimes looked on as non-producers and sometimes as a burden on industry, but to-day they were valued and appreciated, because they were showing the industry better ways of doing many a difficult task. In that connection, the work of the scientists and of the Committees which were working under Dr. Hatfield's leadership was highly valued.

For the rest, the Institute must remain fairly quiet at present, but there was one feature to which he must make a passing reference. The Council had been gratified by a substantial addition to the membership of the Institute of friends in the industry in America. They had shown their willingness to co-operate, and the Institute's membership in America stood at a higher point than it had ever before reached in the history of the Institute. If it had lost members elsewhere, it had gained them in a country with whom there could be the closest co-operation in the future.

Presentation of Papers

The following Papers were presented for verbal discussion: "Apparent Relations between Manganese and Segregation in Steel Ingots," by J. H. Whiteley. "The Application of Spectrographic Methods to the Analysis of Segregates," by F. G. Barker, J. Convey and J. H. Oldfield. "The Ladle Cooling of Liquid Steel," by T. Land.

The PRESIDENT, on behalf of the Council, thanked the authors for their Papers. He thanked the members present for their attendance, and said he knew how difficult it was for many of them to spare time for the purpose, but he hoped that in this way the industry was keeping alive the spirit of inquiry and a thirst for knowledge among the younger members, while the older members were able to contribute from their experience, in such a way as would enable the industry to continue to prosper. He hoped that the Iron and Steel Institute would continue to serve the industry in the future as it had in the past.

(*Concluded in last column.*)

(*Concluded from previous column.*)

The HON. RICHARD G. LYTTELTON (Messrs. Guest, Keen & Nettlefolds, Limited, London) proposed a cordial vote of thanks to the President for his conduct in the chair. The members, he said, very much appreciated the atmosphere which the President had created at that and other meetings, and which materially assisted in promoting the interesting discussions which had been held under his presidency.

The vote of thanks was carried with acclamation, and was briefly acknowledged by the President. The proceedings then terminated.

Reduction in Ferro-Manganese Consumption

United States consumption of standard ferro-manganese, about 15.5 lbs. per net ton of steel, is dictated by four conditions, stated C. H. HERTY, JUNR., of the Bethlehem Steel Company, in a discussion at a recent meeting of the American Iron and Steel Institute, on the question as to how far ferro-manganese consumption can be reduced without affecting steel quality. The conditions were: Specifications set by the consumer, specifications set by the producer to meet physical properties, specifications set by the producer to give the optimum rolling conditions, and open-hearth practice as regards charge, working of the heat and deoxidation practice.

Manganese specifications set by the consumer can be revised downward by balancing the lowered manganese with increased carbon and/or silicon. This rebalancing of composition may, in many cases, require a modification of heat treatment, or a slight revision of existing specifications on certain physical properties, such as the tensile specification on structural steels which are subject to welding. But substitution elements other than carbon and silicon are either much more costly than manganese or are more "critical" from a "strategic" standpoint. A considerable decrease in manganese consumption can be effected by suitable revisions of consumer specifications.

In a large tonnage of steels the manganese content is set to assist in developing the best possible surface qualities in the rolled or finished product. A large saving in manganese can be effected through relaxation of the consumers' requirements on surface.

Open-hearth practice can be regulated to conserve standard ferro-manganese by: (*a*) Increasing the residual manganese by increasing the manganese content of the charge or by lowering the slag volume in the open hearth. Such an increase in residual manganese automatically decreases the ferro-manganese requirement, but if the added residual manganese is obtained from manganiferous ores an increase in cost may result. (*b*) By careful slag control the maximum possible residual manganese from a given charge and the maximum recovery of added ferro-manganese can be assured for a given grade on a high percentage of heats. (*c*) Deoxidation of the heat before the manganese addition, as is now practised in many grades, will increase the manganese efficiency and reduce the requirements of ferro-manganese. (*d*) The manganese efficiency of a ladle addition is about 10 per cent. higher than for a furnace addition. Therefore as much manganese should be added to the ladle as is consistent with the desired quality of the product. (*e*) The substitution of manganese alloys lower in manganese than standard ferro-manganese is entirely feasible for a considerable amount of ferro-manganese, if and when such alloys are available.

These various steps in specifications and practices are capable of markedly decreasing American consumption of ferro-manganese without seriously affecting steel quality.

The Applications of Titanium Oxide in Vitreous Enamels

By S. G. TINSLEY, B.A., B.Sc. (British Titan Products Co. Ltd., Billingham, Co. Durham)

(*Continued from page* 306.)

It seems probable that, in these cases, the frit is saturated with titanium oxide to such an extent that it can exert only a very feeble dissolving action on further quantities of the oxide added at the mill at the temperature of firing the enamel. The opacity developed is quite stable, and very little loss is observed even when the enamel is subjected to a degree of over-firing not usually encountered in works' practice. Nevertheless, this process of opacification suffers from two serious disadvantages:—

(1) Although the opacity is stable, the colour is not, a progressive yellowing of the enamel taking place as time and temperature of firing are increased. In order to ensure identity of colour of various muffle loads, a very close control of firing conditions, not usually possible in plant operation, is needed.

(2) Since the frit is transparent, the whole of the opacity has to be contributed by the titanium oxide added at the mill. The dry biscuit enamel layer is composed of very fine particles of titanium oxide separated by comparatively large granules of transparent frit, an arrangement which is not altered to any material extent during the firing operation. Unless the frit is very finely ground, therefore, the enamel possesses a fine mottled appearance under the microscope and the opacity is not "solid."

A further line of investigation was, therefore, commenced with a view to removing these objections. The effect of frit composition on stability of colour during firing was studied, and the possibility of developing some of the opacity in the frit itself with titanium oxide was also explored.

During the course of this work, it was found that with certain frit compositions, particularly those containing a small proportion of zinc oxide, it is possible to saturate the molten frit with titanium oxide during the smelting operation. On allowing the molten frit to cool slowly, a titanium compound crystallises out in a very finely dispersed state, and the frit becomes opaque. If, on the other hand, the molten frit is rapidly cooled by pouring into water in the usual way, a transparent frit results. Evidently in this case, the titanium compound is still held in super-saturated solution by the enamel glass. However, if this frit is ground with clay, applied to ground-coated steel and fired, an opaque enamel is the result. In other words, quenching, followed by heating to 800 to 850 deg. C., has the same effect in promoting crystallisation as slow cooling from 1,100 to 1,200 deg. C. Frit K.58 is an enamel which behaves in this way.

It smelts easily at 1,100 deg. C., and when quenched in water in the ordinary manner, the frit is transparent, the titanium oxide being retained in super-saturated solution. However, when ground with 5 per cent. clay, and fired at 800 to 850 deg. C., an opaque enamel is the result. The opacity is extremely stable and is not diminished by prolonged over-firing. Moreover, because of the absence of mill additions other than clay or other suspending agent, the gloss of the enamel is extremely good. However, with a single application of 50 grms. per sq. ft., the brightness of the enamel is only 60 per cent., for it has a fairly strong cream colour.

Frit K.58.

Felspar	29.0
Borax	25.5
Quartz	19.5
Sodium carbonate	3.5
Sodium nitrate	4.5
Potassium nitrate	3.0
Cryolite	3.0
Zinc oxide	3.0
Titanium oxide	9.0
	100.0

If the opacity is developed by titanium oxide, as seems likely, it is easy to understand why this is so. The very fine titanium oxide crystals are formed from the molten enamel in the presence of a large excess of sodium compounds and therefore assume the rutile form. It is known that pure titanium oxide in the rutile form develops a strong coloration when heated at high temperatures with traces of iron, and in this case the iron is provided by the impurities in the quartz, felspar and clay in the enamel. Thus a white enamel can be obtained if pure raw materials are used, *e.g.*, precipitated silica in place of the quartz, but such a method is obviously of academic interest only.

A study was therefore made of the effect of frit composition and mill additions on colour and opacity, with a view to the ultimate development of a super-opaque enamel, which would give complete cover in one coat over the ordinary cobalt grip-coat on steel, instead of the two coats, which are usually necessary. Each constituent of the enamel was varied separately throughout the following percentage ranges, and the frits were smelted in 1 kg. batches under standard conditions in a gas-fired crucible furnace.

Batch Compositions.

	Per cent.
Felspar	19—40
Borax	19—32
Quartz	11—30
Sodium carbonate	0—4
Sodium nitrate	0—7
Potassium nitrate	0—4
Cryolite	3—16
Zinc oxide	0—8
Titanium oxide	8—12
Various minor ingredients, such as sodium silicofluoride, barium carbonate, whiting, etc.	0—5

Slips were ground for each frit, using 5 per cent. clay as the sole mill addition, and 16-gauge steel panels, already ground coated, given one application of 50 gms. per sq. ft. dry enamel (one side only = 25 gms. per sq. ft.). These panels were fired for 3 mins. and 5 mins. at 850 deg. C., and opacity, colour, gloss, etc., observed visually. For comparative purposes, the brightness or reflectance of each enamel was determined photoelectrically, and expressed as a percentage of a pure magnesium oxide surface of brightness 100 per cent.

It is significent that of all the enamels falling within these ranges of composition that were smelted, and there were some 200 of them, not one failed to develop opacity on firing, although naturally there were differences in the degree. This does not mean to imply that every enamel having a composition covered by this broad general formula will develop self-opacity on firing, but life is too short to try every possible combination.

On the other hand, the colour of the fired enamel, using clay as the only mill addition, was influenced by its composition to a marked degree, and colours varying from very pale pastel shades of blue through greyish whites to cream whites could be obtained. Generally, the effect of each batch ingredient can be summarised as follows:—

(1) *Felspar.*—Within the range tested, the amount of felspar appeared to have little effect on the tone of the fired enamel.

(2) *Borax.*—A high borax content favoured the development of cream tones.

(3) *Quartz.*—Increases in the quartz content tended to give more neutral whites of higher brightness, but with high percentages, blue tones appeared and "blue specks" were apparent in the frit. With high contents of quartz, the reactions during smelting tended to be incomplete owing to poor fusibility.

(4) *Alkalis* (sodium carbonate, sodium nitrate, potassium nitrate).—High alkali contents gave cream-white enamels, and eventually led to a marked diminution in opacity. Very low alkali contents caused blue tones, and blue specks in the frit.

(5) *Cryolite and Sodium Silicofluoride.*—In a lesser degree, the effects of these ingredients were similar to the alkali compounds.

(6) *Titanium Oxide and Zinc Oxide.*—Although it was possible to obtain good opacity in enamels of this type in the absence of zinc oxide, the hiding power could invariably be improved by its presence. It is significant that optimum opacity and whiteness were obtained when the titanium oxide-zinc oxide weight ratio was in the neighbourhood of two to one, which corresponds roughly to two molecules of titanium oxide to one of zinc oxide. Pronounced deviations from this ratio either way tended to produce off-whites.

(7) *Minor Ingredients.*—Small proportions of calcium compounds, such as fluorspar, whiting and bone ash, gave poor coloured frits, the fired enamels having poor gloss and pronounced green tones. Barium carbonate, in proportions of ½ to 2 per cent., had the effect of correcting the blue tone of some of these enamels, besides being an effective minor flux.

Enamels having a good colour, and developing complete opacity when in one coat applied at a weight of 50 grms. of dry enamel per sq. ft. (both sides) over the ordinary cobalt grip coat and having no mill addition other

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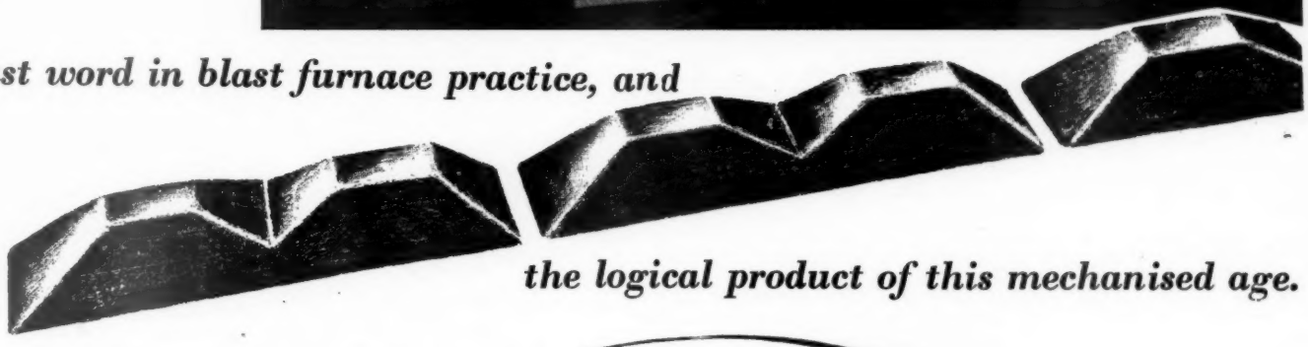

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Titanium Oxide in Vitreous Enamels

than clay, have been found to fall within the following limits of batch composition.

	Per cent.
Felspar	25—30
Borax	20—23
Quartz	24—27
Sodium nitrate	4—6
Potassium nitrate	0—4
Cryolite	4—6.5
Zinc oxide	4—5.5
Titanium oxide	9—11
Barium carbonate	0—1

Frit K.212 is a typical example of such enamels:—

Frit K.212	
Felspar	26.5
Borax	22.5
Quartz	26.5
Sodium nitrate	4.1
Cryolite	6.1
Zinc oxide	4.1
Titanium oxide	9.2
Barium carbonate	1.0
	100.0

When milled with 5 per cent. of clay only, applied in one coat over the ordinary blue-black grip coat at a weight of 50 grms. per sq. ft., and fired at 850 deg. C., the resulting enamel had a brightness of 69 to 70 per cent. of that of magnesium oxide, with a slight cream tone. By adding 2 per cent. of titanium oxide at the mill, this brightness was increased to 74 per cent. Experiments were then made to determine the effect of mill additions generally, and suspending agents in particular, on the colour of enamels of this type.

Effect of Suspending Agents

The first general conclusion which emerged from this work was that progressively increasing amounts of ball or pipe clay added at the mill caused corresponding deteriorations in the tone of the white. However, it is not possible to reduce the clay addition below the figure of 5 per cent. on the frit without the addition of some auxiliary suspending agent such as bentonite, sodium aluminate, and gums, or the strength of the unfired biscuit is lowered to such an extent that tearing is prevalent during firing.

Bentonite, due to its highly colloidal nature, is about five times as efficient as ordinary ball clay in suspending enamels, and the clay can be reduced to 3 per cent. when ½ per cent. of bentonite is added. The latter can be used alone —only 1 per cent. is needed—but the enamel slip becomes very "short," and its consistency is difficult to control.

Suspension can be effected by means of a 1 per cent. addition of sodium aluminate. The mill batch is ground with the aluminate added, and the slip is set up with dilute hydrochloric acid or ammonium chloride. The partial precipitation of alumina gel from the sodium aluminate solution occurs, and this suspends the frit particles by the establishment of a structure throughout the slip. A combination of 1 per cent. sodium aluminate and ½ per cent. bentonite provides a good suspending agent, although the amount of electrolyte required is critical, and the "set-up" would be difficult to control in practice. Such a slip would probably be satisfactory for application by spraying, but its consistency would not be suitable for dipping. The same remarks apply to the use of gums.

The improvement in the brightness of the fired enamel obtained by the use of these combinations of suspending agents with varying amounts of titanium oxide added at the mill, can be seen from the results given in Table III. The slips were all ground to a fineness of approximately 10 per cent. on a 180-mesh sieve (calculated on the frit content of the slip), applied by spraying at 50 grms. per sq. ft. in one coat to ground coated 16-gauge steel, and fired for 5 mins. at 850 deg. C.

The same experimental procedure was adopted for the study of the effect of other mill additions on the colour of Frit K.212 using 5 per cent. of clay as the suspending agent. It

TABLE III.

TiO_2 added at mill.	Suspending agents.	Per cent. brightness. (MgO = 100).
0 per cent.	5 per cent. clay	70
	3 per cent. clay + ½ per cent. bentonite	73
	1 per cent. sodium aluminate + ½ per cent. bentonite	78.5
1 per cent.	5 per cent. clay	71
	3 per cent. clay + ½ per cent. bentonite	75
	1 per cent. sodium aluminate + ½ per cent. bentonite	81
2 per cent.	5 per cent. clay	74
	3 per cent. clay + ½ per cent. bentonite	78
	1 per cent. sodium aluminate + ½ per cent. bentonite	82
4 per cent.	5 per cent. clay	77
	3 per cent. clay + ½ per cent. bentonite	82
	1 per cent. sodium aluminate + ½ per cent. bentonite	82

was found that Frit K.212 was compatible with the usual opacifiers, such as tin oxide and zirconium oxide, but since the opacity developed by the frit itself is so complete, and very little improvement in brightness is obtained by adding even 5 per cent. of tin oxide, their use as mill additions to this type of enamel is not justified on economic grounds. One per cent. of mill additions of antimony pentoxide and sodium antimoniate improved the brightness considerably. This result is of academic interest only, since the use of either of these compounds as mill additions in the majority of wet process enamels is not desirable. They are both oxidising agents, and it is already well known that oxidising agents improve the colour of titanium enamels.

Additions of other oxidising agents, such as sodium, potassium and magnesium nitrates, also gave the same result. Thus, with an addition of ½ per cent. of potassium nitrate, the brightness of the enamel was increased from 70 to 77 per cent. Amounts of soluble salts in excess of ½ per cent. should not be used, however, in view of the danger of scumming. This amount is also sufficient to "set up" the slip; ¼ to ½ per cent. of magnesium carbonate improves the brightness to a similar extent, and also sets up the slip.

The recommended mill additions for enamels of the Frit K.212 type are therefore as follow:

Suspending agents:—3 per cent. clay (5 per cent. clay maximum); ½ per cent. bentonite.

Colour improvers:—¼ per cent. potassium nitrate; ¼ to ½ per cent. magnesium carbonate; 2 to 4 per cent. titanium oxide.

The fired enamel usually has a brightness of 78 to 80 per cent. when applied in one coat at 50 grms. per sq. ft., with a very slight cream tone. This degree of brightness corresponds to complete hiding of the ground coat, and no show-through can be detected. For comparison, measurements of the brightness of flat surfaces of white enamelled articles on the market gave figures of from 60 to 73 per cent., and most of these had two cover coats. The effect of fineness of grinding, application weights, and firing conditions on the degree of opacity of Frit K.212 were next studied.

It was found that the opacity of the enamel was quite unaffected by the degree of grinding of the slip. The range studied was from 45 per cent. residue on 180 mesh, to under 1 per cent. on 325 mesh (A.S.T.M. sieves), the figures referring to slip containing 100 grms. of frit. This result was not entirely unexpected, since the opacity of the enamel is developed by the formation of small crystals throughout each granule of frit, and is therefore unaffected by the size of these granules. In this respect, enamels of the Frit K.212 type differ from conventional super-opaque enamels whose opacity largely depends on large mill additions of opacifier and very fine grinding. Nevertheless, very coarse grinding should naturally be avoided if a smooth surface of good gloss is to be obtained, and very fine grinding is liable to cause tearing on firing. The fineness limits recommended are from 10 per cent. on 180 mesh to 1 per cent. on 325 mesh. Within this range no visible difference in the appearance of the fired enamel is discernible, although, of course, the consistency of the slip varies over a wide range.

TABLE 4.—*Firing Range of Frit* K. 212.

U. F. = Underfired.
O.K. = Correctly fired.
O.F. = Overfired.
Times in minutes.

Temperature.	1½	2	3	4	5	6
750° C.	—	—	66 per cent. U.F. Bluish	68 per cent. U.F. Bluish	71 per cent. U.F. Bluish	75 per cent. O.K.
800° C.	—	—	74 per cent. U.F. Bluish	75 per cent. O.K.	78 per cent. O.K.	77·5 per cent. O.K.
850° C.	—	67 per cent. U.F. Bluish	76 per cent. O.K.	77 per cent. O.K.	78 per cent. O.K.	—
900° C.	74 per cent. U.F. Bluish	76·5 per cent. O.K.	78 per cent. O.K.	78 per cent. O.F.	—	—

In order to study the effect of firing conditions on Frit K.212, the following mill batch was ground until the fineness was such that a slip containing 100 grms. of frit left a residue of 1 grm. on a 325 mesh screen.

	Gms.
Frit K.212	1,000
Clay	30
Bentonite	5
Magnesium carbonate	5
Titanium oxide	20

This was applied by spraying to ground coated 16-gauge steel plates at 50 grms. per sq. ft., which

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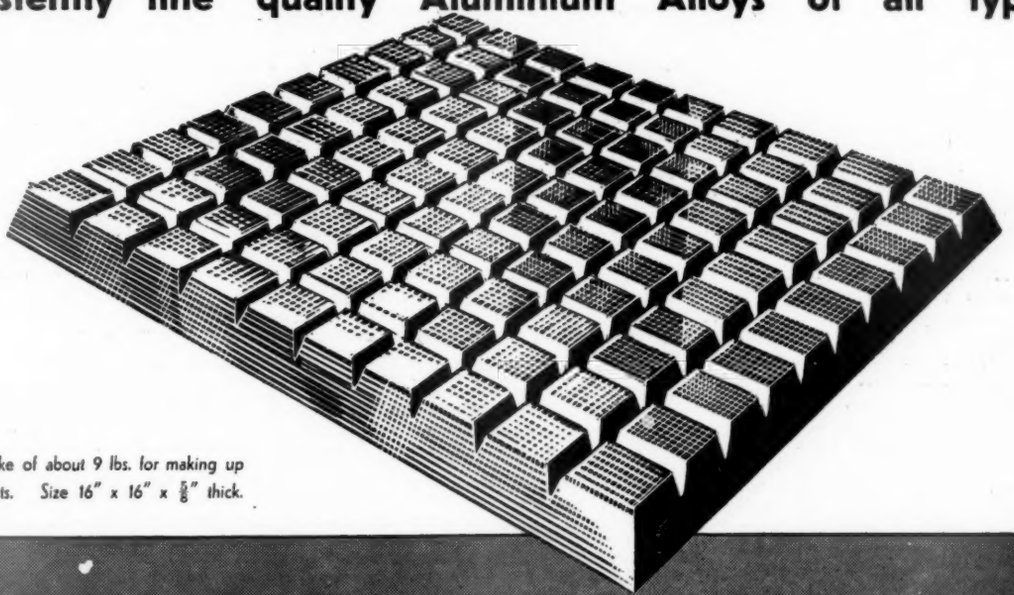

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were subsequently fired according to the Table IV, in which the reflectance figures for each firing condition are given.

The firing conditions therefore range from 4-6 mins. at 800 deg. C., 3-5 mins. at 850 deg. C., and 2-3 mins. at 900 deg. C., on 16-gauge steel. It is significant that higher brightness values are obtained with longer firing times at a given temperature. This shows that the process of crystallising out of the opacifier particles requires a definite minimum time for completion.

Brightness versus Application Weight

The slip from the previous experiments was also used for determining the relation between application weight and opacity as measured by the brightness or reflectance factor. The results are shown graphically in Fig. 1, on which are

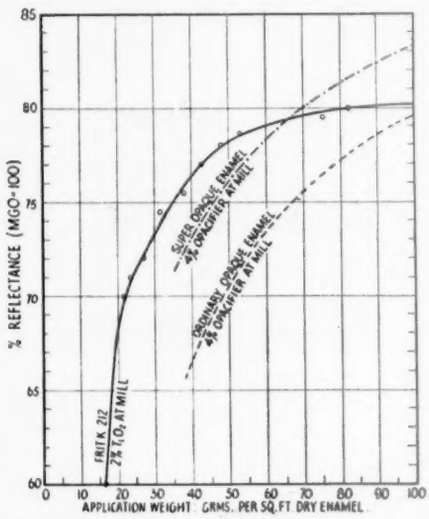
% REFLECTANCE (MGO=100)
APPLICATION WEIGHT GRMS. PER SQ.FT DRY ENAMEL
SUPER OPAQUE ENAMEL 4% OPACIFIER AT MILL
ORDINARY OPAQUE ENAMEL 4% OPACIFIER AT MILL
FRIT K.212 2% TiO_2 AT MILL

FIG. 1.—REFLECTANCE PLOTTED AGAINST APPLICATION WEIGHT.

also reproduced for comparative purposes a corresponding graph for a super-opaque enamel and one for an ordinary opaque enamel. The latter was taken from "A Manual of Porcelain Enamelling," by J. E. Hansen, Ferro Enamel Corporation, U.S.A., 1937. It is obvious from this graph that for economical working, satisfactory opacity is obtained with one application of from 30 to 59 grms. per sq. ft., the reflectance ranging from 75 to 78 per cent.

That an enamel of the Frit K.212 type, developing such exceptional opacity by the crystallisation of opacifying particles from the first matrix during firing also possesses good acid-resisting properties was demonstrated by testing it according to the I.V.E. bowl method. After attack by 3 per cent. oxalic-acid solution for 1 hr. on the water bath, the loss in weight was 30 to 35 milligrams per square decimetre, a result which places the enamel in the Grade A category—*i.e.*, most acid resistant—of the classification recommended by the I.V.E.

It has been made quite clear in the foregoing description of these titanium-opacified enamels that the whole of the experimental development work has been carried out in the laboratory, using small-scale operations. It will be realised, therefore, that the translation of the results so obtained into works' practice will almost certainly necessitate small modifications in batch formulæ and methods of processing in order to achieve the desired results under various plant conditions.

In conclusion, the author wishes to express his thanks to the directors of British Titan Pro-

(*Continued in next column.*)

The New Insurance and Pensions Act

The National Health and Contributory Pensions Act, 1941 (Part I), introduces new provisions of which cognisance should be taken, such as increases in contributions and benefit rates, and non-manual workers with earnings up to £450 per annum (the former limit being £250 per annum) are brought into compulsory insurance, all these provisions becoming operative from January 5, 1942; manual workers are insurable as employed contributors, irrespecuve of amount of earnings.

Benefits and Contributions

The new sickness benefit rate for men is 18s. weekly, for married women 12s., other women 15s.; disablement benefit 10s. 6d. for men, married women 8s., other women 9s. Fully-insured persons are only entitled to the foregoing (this term means persons with at least two years' insurance with 104 contributions paid); if the conditions detailed cannot be met, sickness benefit is payable at reduced rates if at least six months' insurance with 26 contributions can be proved, the new rates being 12s. for men, 10s. 6d. for women. Disablement benefit is only payable to those with the "104 weeks' contributions" qualifications as above. The above rates are an all-round increase of 3s. weekly.

The new "employed rate" (increased 2d. weekly) is 2s. for men, 1s. 7d. for women, the employer recovering 1s. and 10d. respectively from employee. For men employed after 65, and women 60 (all payable by the employer), the rates are increased one penny, the new weekly rate for men being 1s., for women 9d.

With no actual mention of increases for ordinary voluntary contributors in this new Act, it may have been thought that the increases will not apply for this class, but former Acts state that voluntary contributors pay at the employed rate (employer and employed share combined), so voluntary contributors insured under the combined scheme (Health Insurance and Pensions together) will pay 2s. weekly, women 1s. 7d. weekly, if insured separately for Health Insurance 11d. and 10½d. respectively, the increase being in each case 2d. weekly. On the other hand, the new benefit rates will apply to voluntary contributors, and the following concerning medical benefit should be noted. Until this Act, medical benefit was not available for voluntary contributors, if the total income exceeded £250 per annum; now this is obtainable if total income does not exceed £420 per annum; if medical benefit is not allowed the contributions are 3d. less.

Points to Note

Persons in employment who have continued as voluntary contributors when going out of compulsory insurance by their salary exceeding £250 per annum will return to the "employed contributor" class with employer paying part of the contribution, instead of the insured person paying all—that is, if salary is not over £420, when voluntary insurance can of course be continued. Voluntary contributors who are on own account, employers and self employed, will continue in such voluntary insurance, paying the increased contributions and receiving the increased benefits, with medical benefit if the total income as shown does not exceed £420 per annum.

The following topical tips may be welcomed by those now brought into compulsory insurance for the first time. An approved society (most friendly societies and insurance companies are approved societies) should be selected, as if insurance is effected as a deposit contributor, through a post office, benefits are only payable according to the amount of contribution payments registered; a society cannot refuse membership purely on account of age. The employee gets the cards and hands them to the employer, but the society ordinarily will provide this; otherwise cards are obtainable at most post offices, be it noted, without becoming a deposit contributor. Medical benefit becomes available immediately on entering insurance, and the entrant can select any doctor on the panel.

(*Continued from previous column.*)

ducts Company, Limited, for permission to publish this Paper.

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(1) Mellor's "Comprehensive Treatise of Inorganic and Theoretical Chemistry." Vol. 7, pp. 51-52.
(2) *Ibid.* Vol. 6, pp. 842-845.
(3) "Foundry Trade Journal," December 7, 1939, p, 395.

Industrial Electrical Equipment

AREA ORGANISATION

The Director of Industrial Electrical Equipment has set up an area organisation to give advice and assistance to war factories in matters arising out of damage by enemy action in industrial electrical equipment. An Electrical Adviser has been appointed in each of the Defence Areas, and a number of electrical engineers in the area are available as his assistants in case of need. All these gentlemen serve in an honorary capacity.

This area organisation has undertaken, on behalf of the D.I.E.E., a survey of the electrical repair capacity and the stocks of electrical equipment which could be called upon in an emergency. Close collaboration is maintained with the Machine Tool Control area and repair organisation, the Ministry of Aircraft Production emergency services organisation, and the Ministry of Works and Buildings emergency works department. The services of the Electrical Advisers and their assistants are available through these organisations.

The Area Electrical Advisers are as follow:—

Northern Area, Mr. J. Clement, British Thomson-Houston Company, Limited, Ellison Place, Newcastle-upon-Tyne, 1. East and West Ridings, Mr. L. G. Bryden Crompton Parkinson, Limited, 4/6, New York Road, Leeds. North Midland, Mr. B. Gill, Midland Dynamo Company, Limited, 64, Belgrave Gate, Leicester. Eastern, Mr. J. H. Enion, Igranic Electric Company, Bedford. London and South Eastern, Mr. A. W. Berry, Crompton Parkinson, Limited, Electric House, Victoria Embankment, London, W.C.2. Southern, Mr. M. G. R. Elliott, Lancashire Dynamo & Crypto, Limited, 94, Petty France, London, S.W.1. South Western, Mr. A. H. Topham, Mawdsley's, Limited, Dursley, Glos. Wales, Mr. H. Coope, Metropolitan-Vickers Electrical Company, Limited, Mervyn House, Frederick Street, Cardiff. Midland, Mr. T. G. Travis, General Electric Company, Limited, Witton, Birmingham, 6. North Western, Mr. J. I. Law-Brooks, Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester. Scotland, Mr. G. S. Helme, Lancashire Dynamo & Crypto, Limited, 80, Blythswood Street, Glasgow. Electrical Adviser to Northern Ireland Ministry of Commerce, Mr. H. W. Richardson, District Admiralty Electrical Engineer, Harland & Wolff, Limited, Queen's Island, Belfast.

Law Report

Failure to Take up Work as Directed

At a Hanley Court, Bertram Frederick Eastwood, of Park Avenue West, Wolstanton, a director of a Potteries engineering firm, was summoned for failing to comply with a Ministry of Labour direction as to employment.

Mr. V. A. McKnight, who prosecuted, said the defendant was a partner in a firm of engineers who were now engaged on Government work. Last July he was ordered to report to a factory engaged on Government work as a tool-room fitter. He appealed against that direction, and his appeal was dismissed by an Appeal Board on August 9. A second direction was issued to him to start work on August 13, and subsequently the defendant wrote to Lord Beaverbrook. Further inquiries were made, but the direction had not been withdrawn, and as the defendant had failed to take up the work he was ordered to do, proceedings had been taken against him. Mr. McKnight submitted that the question as to whether the work was suitable or not had nothing to do with the Court.

Evidence was given by a Ministry of Labour official, who said that Mr. Eastwood told him that he did not comply with the direction because, as a working partner in a firm engaged on work of national importance, he considered that he was performing work of equal importance to that which the National Service Officer had directed him.

The Stipendiary said that the defendant had abrogated to himself the right to decide which was the more important work to be done. Whether he was right or wrong it was not for him (the Stipendiary) to decide. He had merely to say whether there had been a breach of the direction, and in his opinion there had been a breach.

The defendant would be fined £20 and have to pay £3 11s. 3d. special costs.

"Can't I sell you a pig in a poke Mr Brown"?

Mr. Brown, as a knowledgeable foundryman, is hardly likely to jump at the offer. Why should he? He knows that sand-cast pig will have a good deal of sand adhering to it, which will have to be fluxed with limestone at the cost of extra coke. There will also be a proportion of unwieldy sows which will add to his troubles.

No! Mr. Brown will probably buy Workington machine-cast hematite iron, knowing that every slab in a cast is uniform in analysis, that it comes in handy-sized pieces which do not "hang" in the cupola. He knows, too, that he is getting 100% of usable iron for his money and will require less limestone and coke in the cupola. In short, he knows exactly what he is buying.

THE UNITED STEEL COMPANIES LTD

WORKINGTON IRON & STEEL CO.
BRANCH OF THE UNITED STEEL COMPANIES LIMITED
WORKINGTON CUMBERLAND

W 56

The Week's News in Brief

Trade Talk

A NEW SPECIFICATION, No. S61-1940, for cast iron has been issued by the Canadian authorities.

THE REGISTERED AND HEAD OFFICE and London sales office of Baldwins, Limited, are now at 6, Broadway, Westminster, London, S.W.1.

THE NELSON STEEL HATCH COVER COMPANY, LIMITED is being wound up voluntarily. The liquidator is Mr. C. T. Fortune, Collingwood House, West Hartlepool.

THE T.U.C. GENERAL COUNCIL has been notified that there will be a one-day holiday only at Christmas—as far as possible on Christmas Day. A Government statement has been made to this effect.

DARLINGTON CORPORATION has accepted the tender of Humphreys & Glasgow, Limited, for the supply and installation of additional water-gas and other plant at the gasworks. The total cost will be £20,000.

THE ASSOCIACAS BRASILEIRA de Normas Technicas, the Brazilian Standards Institution, has been formed on lines similar to its British counterpart and with similar objects. Mr. Paul Sá is the secretary-director.

A JOINT COMMITTEE representative of the employers and workers in the Welsh tinplate trade has been set up to investigate the possibility, as a wartime measure, of introducing more female labour into the industry.

THE CUMBERLAND IRON-ORE MINERS' branch of the National Union of General and Municipal Workers have sent a resolution to the Minister of Supply protesting against the sentence of two months' hard labour passed at Whitehaven on two men who failed to obey an order to return to work in the iron-ore mines.

THE NATIONAL ARBITRATION TRIBUNAL will hear the claim of the unions forming the Engineering Joint Trades Movement for an increase of 10s. per week on December 5, and the claim for an increase of 4d. per hour, submitted by the Amalgamated Engineering Union and the National Union of Foundry Workers, on December 8.

DEALINGS COMMENCED last week in the £1 "A" ordinary shares of Harland & Wolff, shipbuilders and engineers, of Belfast. There are 5,200,000 of these shares, and 2,000,000 are being introduced to the market. The 5,200,000 shares were issued under the company's reconstruction scheme of 1937 in part satisfaction of creditors' claims.

THE INDUSTRIAL COURT has decided that women employed at the Yorkshire Copper Works, Leeds, on production operations as part of a production unit and paid a production bonus shall receive an output bonus calculated similarly to the men's on the women's rate of pay. The decision is a result of a question of interpretation raised by the National Union of General and Municipal Workers.

THE BOARD OF TRADE have made the Export of Goods (Control) (No. 41) Order, 1941 (S.R. & O., 1941, No. 1886, price 1d.), which came into force on December 1. The terms of this Order make it clear that the requirement of an export licence for the export of iron and steel castings, forgings, stampings and pressings does not extend to such machinery parts as are not covered by other headings in the Export Control List.

A WHOLE-DAY CONFERENCE on "Air Raid Precautions and the Engineering Industry" is to be held jointly by the Institution of Mechanical Engineers and the Institutions of Civil and Electrical Engineers, at the Central Hall on Tuesday, December 9, 1941. Admission to any of the sessions is restricted to Corporate Members only of the three Institutions who have applied for, and hold, the special admission tickets.

SIR GEORGE SCHUSTER, M.P., speaking in the Commons debate on the Address, expressed the opinion that the 100 per cent. Excess Profits Tax levied now was doing grave injury to the public interest. It was causing injustice to one business or another, and it was a direct incentive to wasteful expenditure and unsound methods. The Chancellor of the Exchequer should appoint a small expert committee to report to him the effect of the tax on industry.

SOME 3,600 MEN AND WOMEN in a North Country iron and steel works are to forgo their Christmas holidays. The managing director of the firm has sent to Lord Beaverbrook, the Minister of Supply, a signed copy of two resolutions passed by the workers' representatives. One resolution reads "that our maximum endeavours will be devoted to sustain the national war effort and to support our allies," and the other "that as a token of our intention we will forgo our Christmas holidays so that the normal production can continue."

IN AN ADDRESS on the "Position of the Locomotive in Mechanical Engineering," given by Mr. W. A. Stanley, chief mechanical engineer of the L.M.S. and President of the Institution of Mechanical Engineers, at a meeting of the North-Eastern Branch, the speaker said that the modern locomotive had to pay for its greatly improved performance by more expensive design and construction, but per unit of work done it was cheaper. If too narrow a view was taken, it was possible to cling too long to old designs for the sake of low costs more apparent than real.

THE MINISTRY OF LABOUR announces the raising of ages of reservation in building and civil engineering occupations in whatever industry the men concerned may be employed. Constructional iron and steel fitters and erectors will be reserved at 25 in protected establishments and 35 elsewhere (instead of at 18 and 30 years respectively), and sheeters and iron roofers at 30 in protected establishments and 35 elsewhere (instead of 23 and 30 years respectively). Applications by employers for deferment of the calling up of men affected by these changes must be made by December 1.

THE COMPANIES REGISTRATION OFFICE gives notice that at the expiration of three months the names of the undermentioned companies will, unless cause is shown to the contrary, be struck off the register, and the companies will be dissolved:—Darlington Rustless Steel & Iron Company, Limited; Gateshead Foundry, Limited; British Molybdenum Company, Limited; British Unified Mechanisms, Limited; "Foundries," Limited; McAlpine Ferro-Concrete Company, Limited; Patent Axle-Box & Foundry Company (1934), Limited; Superstrength Metals, Limited; Widnes Foundry (1925), Limited.

THE BOARD OF TRADE have issued a general licence (S.R. & O., 1941, No. 1,741) permitting the supply, outside quota, of anti-dermatitis preparations to firms engaged in certain specified activities, including the production of coal, the supply of electricity and gas, engineering, metal plating, and the manufacture and use of chemicals. Firms wishing to obtain these supplies must send to their supplier a declaration stating the value of the goods required and the nature of the business which the firms carry on. They must also state that the goods will be used solely for the prevention of dermatitis among their employees, and will not be resold to the public.

New Companies

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Rhodio Alloys, 90, Queen Street, London, E.C.4—Metallurgists, alloy manufacturers, etc. £1,000. D. H. D. Freeman.

H. B. Thomas, 16, Brownlow Mews, Gray's Inn Road, London, W.C.1—Engineers, founders, metal workers, etc. £5,000. H. B. Thomas, K. Shepherd, and W. H. Dubery.

Industrial Heat Company (Great Britain)—Manufacturers of and dealers in metallurgical furnaces for the heat-treatment of metals, etc. £1,000. J. O'Brien, 30, Croftdown Road, Harborne, Birmingham, 7.

South Wales Switchgear—To take over the business carried on by Whitehead Switchgear & Inventions, Limited. £10,000. F. W. Edmonds and C. F. Cooper, 18, Austin Friars, London, E.C.2, subscribers.

Rainwater Goods Price Increase

The Minister of Supply has made the Control of Iron and Steel (No. 17) Order, 1941, increasing the maximum price of rain-water goods, gutters and connections by a further 6 per cent. over the pre-war price, making the total increase 27 per cent. The Order will come into force on December 1.

Personal

COMMANDER SIR CHARLES W. CRAVEN (chairman and managing director of the English Steel Corporation, Limited), has been re-elected chairman of the Industrial Welfare Society.

MR. ANDREW HOPPER, commercial manager of Parsons Marine Steam Turbine Company, Limited, Wallsend, for the past five years, has been elected a director of the company. Mr. Hopper served his engineering apprenticeship with the company.

MR. T. S. PEACOCK has resigned from the position of managing director of Guest, Keen & Nettlefolds, Limited, whom he will continue to serve as deputy chairman. He has been presented with an illuminated address to mark the occasion. It is in book form and contains the signatures of all the members of the Black Bolt and Nut Association of Great Britain and of the Bright Bolt and Nut Manufacturers' Association. It is 50 years next February since Mr. Peacock arrived at Darlaston to take up his industrial career.

DR. J. L. MILLER, M.I.E.E., M.Amer.I.E.E., by arrangement has resigned his position as chief research engineer to Ferranti, Limited, and is joining British Insulated Cables, Limited, as deputy chief engineer. Dr. Miller was educated at Liverpool University, and after receiving the degree of Ph.D. in 1925 for post-graduate research, joined the Metropolitan-Vickers Electrical Company as a college apprentice. He later took up a position with Ferranti, Limited, as head of the high-voltage laboratory, where he became established as a research worker in the insulation, transformer, high-voltage, transmission line, transient, high-speed oscillographic and surge absorber fields, and recently was appointed to the post of chief research engineer, with the duties of facilitating the more centralised direction of Ferranti research and development and collaboration with Government services. For his various published contributions the degree of D.Eng. was conferred upon him by Liverpool University in 1934.

Obituary

MR. JOHN ROBERTSON THOM, of Perth, a director of John Wallace & Sons, Limited, agricultural engineers, Glasgow, died on November 16, aged 52.

MR. WILLIAM PENROSE-GREEN, chairman of Thomas Green & Sons, Limited, engineers, of Leeds, and of the Kirby Banks Screw Company, Limited, has died at the age of 81. He was a former Lord Mayor of Leeds.

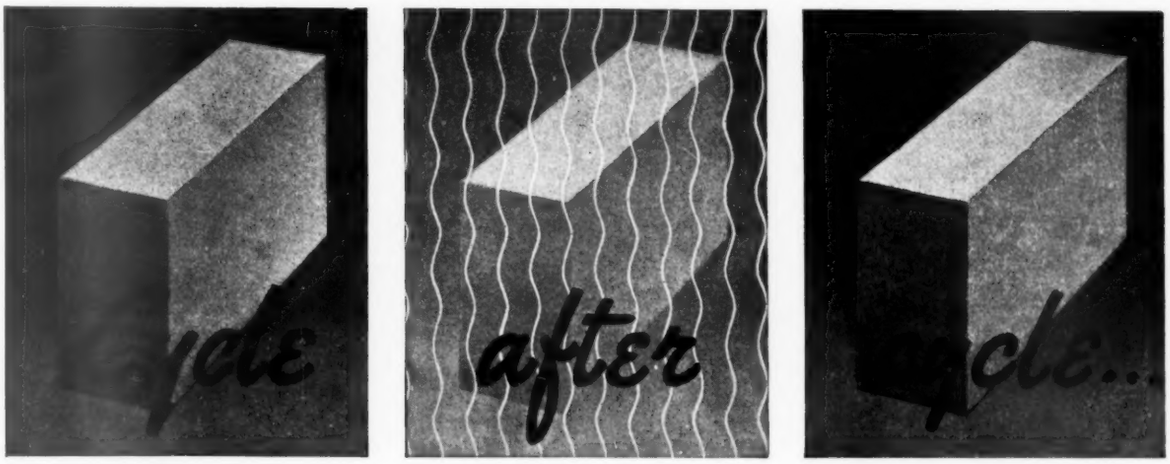
MR. THOMAS STOKES MAYER, managing director of Thomas Mayer & Company, Limited, Crown Bolt and Nut Works, Darlaston, died recently, aged 62. He joined at an early age the firm of which his father was the founder, and became managing director in 1927.

MR. JOHN STANLEY TYZACK died at Carlton, Notts, on November 15. He was 64 years old, and was chairman and governing director of W. A. Tyzack & Company, Limited, high-speed steel makers. This business was established by his father, the late Mr. W. Alexander Tyzack, and he joined it as a young man.

MR. ALFRED ORMESBY COCHRANE, one of the pioneers of the Cleveland iron trade, died at Nunthorpe, Middlesbrough, on Saturday week at the age of 91. A native of Stourbridge and a son of a prominent Staffordshire industrialist, Mr. Cochrane established the Ormesby Ironworks and Foundry at Middlesbrough in 1875 and was actively associated with that enterprise for nearly half a century.

MR. S. C. LLOYD, chief engineer and sales manager of the Industrial Control Department of Metropolitan-Vickers Electrical Company, Limited, has died after a short illness. He joined the company in January, 1919, as chief engineer, and subsequently he also became sales manager. His career previously included periods of service with Ferranti, Limited, Dick Kerr & Company, Limited, and Crompton & Company, Limited.

MR. J. HUNTER, of Whitehaven, died suddenly recently. Mr. Hunter was secretary of the Distington Hematite Iron Company, Limited, and office manager of the Workington Iron & Steel Company (branch of the United Steel Companies, Limited). Aged 67, he began his career as a boy in the office of the Moresby Coal Company, Limited, and rose to the post of secretary before the company was amalgamated with the Workington Iron & Steel Company.



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CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister, Steel Moulders' Compositions.* SILLIMANITE: *Tank Blocks, Bricks and Cements.* SANDS: *Moulding, Brick Facing, Silica, Glass.*

Raw Material Markets

On the whole, the pig-iron position is quite healthy. Ample supplies of high-phosphorus iron are on hand to meet the needs of all users; consumption of this type of iron has been raised by the fact that it is now used extensively as a substitute for qualities of iron less easily procurable. On the other hand, smaller tonnages are going to the light-castings foundries, which in normal times are the largest consumers. Hematite production appears to have been expanded of late, but conditions regulating distribution remain as rigid as ever, and stocks are being accumulated. Considering the many changes and difficulties of the steel industry, the situation is very satisfactory, and the makers are meeting essential demands as promptly as is feasible in the circumstances.

Pig-Iron

MIDDLESBROUGH—Ironmakers on the North-East Coast are fully employed on the manufacture of material for the steelworks, and no furnace capacity is available for the production of Cleveland foundry iron, which was formerly made on a large scale to cope with the requirements of local users, buyers in Sheffield and other districts of England, and also of Scottish foundries. Fortunately, consumers are able to get all the foundry iron they need from furnaces in the Midlands, and many buyers have been able to secure tonnages in excess of their immediate wants. Stocks of hematite are quite appreciable, but the Control authorities are keeping these intact for future use. Licences for the acquisition of hematite are only granted to buyers who are engaged on vital contracts and whose needs cannot be satisfied by other grades of iron. The supply of basic iron to the steel plants is very satisfactory.

LANCASHIRE—Business in the light-castings trade remains somewhat restricted, and few works are in a position to maintain continuous operations. Thus, the demand for iron from this source is well below the normal level. Jobbing foundries for the most part are also quietly placed, with the exception of those catering for the machine-tool trade. The machine-tool industry itself is, of course, very active, while heavy electrical engineers are also absorbing considerable tonnages of iron. Hematite remains difficult to obtain, but special refined irons are being taken up steadily to replace it.

MIDLANDS—Munitions and armaments production is keeping heavy engineers and machine-tool manufacturers employed to capacity, with the result that the demand for foundry iron from these sources is exceptionally high. Low- and medium-phosphorus irons are fairly easily obtained, but the hematite situation remains very tight, with little likelihood of any early improvement, despite larger stocks now held by the Control. The authorities have no wish to jeopardise the future supply by the distribution of existing reserves at random, and there can be no doubt that their policy is correct. Refined iron continues to be used on a wider scale, but the demand is being met promptly. High-phosphorus iron is plentiful, so that the position of users who are having to make use of this type of iron because of the shortage of other descriptions is considerably eased. The light-castings industry is taking up only comparatively small tonnages, as work for this section is spasmodic and does not amount to any large volume in the aggregate. Many foundries are utilising scrap metal in their mixtures; it is not always possible for them to secure all the steel scrap they require, but cast-iron scrap is readily forthcoming.

SCOTLAND—Deliveries of foundry iron have been slightly irregular of late, but it is not expected that this position will be anything more than a temporary phase. Marine engineers are taxing the outputs of the heavy engineering foundries to the utmost, in conjunction with a strong demand from other consumers. Dull conditions continue among most of the light-castings foundries, and there is little prospect of much improvement while industry is on a wartime basis. High-phosphorus iron is arriving from the English Midlands in adequate quantities, and the loss of the Cleveland district as a source of supply is not causing any real inconvenience.

Coke

Deliveries of foundry coke for a long time past have been quite sufficient to cope with demands and, in fact, it has been possible for large stocks to be accumulated. It may be expected that there will be some recession in the flow of supplies some time during the winter months, but few consumers are likely to be handicapped. A price of 62s. 9d. per ton is still quoted for Durham best foundry coke, delivered Birmingham and Black Country stations.

Steel

Development in the production of alloy steels has been far-reaching and rapid, and the steel industry, in co-operation with Government authorities, has done a lot towards meeting the ever-increasing requirements of the munitions works, which are utilising alloy steels, as distinct from ordinary carbon qualities, on an increasing scale. This has entailed appreciable changes in the operations at steel plants, but the changeover has been accomplished with commendable speed and thoroughness. Peak levels of production have by no means been reached yet, but additional units are regularly being brought into commission. A certain tonnage of alloy steel is being imported, but it is hoped and expected that foreign purchases will be kept at a reasonably low ebb.

Scrap

Although imports of scrap iron and steel have been curtailed of late, adequate deliveries of home-produced metal are reaching consumers in most instances. While the present position is generally eminently satisfactory, some concern is expressed regarding the future; it is believed that measures will be taken to ensure a steady flow of supplies, but strenuous efforts will undoubtedly be called for. At the moment, many works are turning down offers of additional deliveries owing to congested storage accommodation, but there are certain descriptions, especially heavy steel scrap, which are in short supply.

Metals

COPPER—Owing to the virtual black-out with regard to the statistical position of copper and other non-ferrous metals, it is not possible to ascertain the balance between supply and demand. It is certain that consumption has never been at a higher level, and that essential requirements are being met satisfactorily, but the rigour with which ordinary domestic business is being curtailed suggests that it is necessary to maintain a close watch on the situation. The policy of the Control all along has been to safeguard future requirements, and it is not expected that there will be any change in their attitude while the demand for the metal for war purposes is so insistent.

TIN—A meeting of the International Tin Committee was held in London on Monday, when the question of the continuation of the present tin control agreement, which expires on December 31 next, was again considered. A communique issued after the meeting stated that the Governments of Bolivia, the Belgian Congo, the Netherlands East Indies, Nigeria and Malaya had accepted the standard tonnages recommended by the Committee and had agreed also to the draft agreement proposed for the regulation of tin control for a further period of five years from January 1, 1942. The Government of Thailand has not yet accepted either the form, or the whole content, of that draft agreement, and it rejects the standard tonnages proposed. Alternative proposals have been made by them, which the Committee is unable to recommend for acceptance. The Committee have recommended that the control agreement and the standard tonnages should be accepted by the Governments concerned, even if the Thai Government should finally be unable to accept the draft agreement, and the standard tonnages the Committee propose. Should the Thai Government eventually decline to join in the system of control, which the Governments representing approximately 93 per cent. of the recent production of the present signatory countries have already accepted, the Committee have suggested certain alterations in the scheme to safeguard the position of the participating countries. On the assumption that the five Governments mentioned above will accept the recommendations, the Committee have fixed the quota for the period from January 1 to June 30, 1942, at 105 per cent. of the new standard tonnages. This percentage corresponds closely to 130 per cent. of the standard tonnages under the current agreement.

The standard tonnages proposed in the new agreement are:—Belgian Congo, 20,178 tons; Bolivia, 46,768; Malaya, 95,474; Netherlands East Indies, 55,113; Nigeria, 15,367; Thailand, 18,500 tons. These tonnages are in proportion to the exports from the countries specified during the period from July 1, 1940, to June 30, 1941. The Committee also recommend that the present buffer stock scheme, which would normally expire on December 31, should be continued for the period of the main tin control scheme.

The Board of Trade has informed the London Metal Exchange that the question of exporting tin to the United States and elsewhere is being kept constantly under review by the Ministry of Supply and the Board of Trade, and that if there is any change in the present policy, under which no export licences for tin are being granted, the Exchange will be notified. The Board of Trade added that if and when exports of tin to the United States are resumed, it is probable that the procedure laid down on March 8 last will be followed. This procedure was that applications to export tin in any one month must be made at the latest by the fifteenth day of the preceding month. It was also stipulated that any exports licensed for a given month must actually take place in that month.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £256 10s. to £257 10s.; Friday, £256 10s. to £256 15s.; Monday, £257 15s. to £258; Tuesday, £257 to £257 5s.; Wednesday, £257 15s. to £258 5s.

Three Months—Thursday, £260 15s. to £261; Friday, £260 to £260 5s.; Monday, £261 to £261 10s.; Tuesday, £260 5s. to £260 10s.; Wednesday, £260 15s. to £261.

SPELTER—Priority consumers of spelter continue to absorb the bulk of deliveries in this country. Brassmakers are fully booked up with urgent orders for the Government and other important purchasers, and consumption of high-grade metal in this section is very substantial. Galvanisers, on the whole, are not very busy, and there is a certain amount of g.o.b. metal available which would in normal times have been consumed in this trade.

LEAD—All essential users of lead are getting their requirements satisfied readily, but other consumers are not finding it quite so easy to obtain supplies as they did a few months ago, owing to tighter conditions imposed by the Control.